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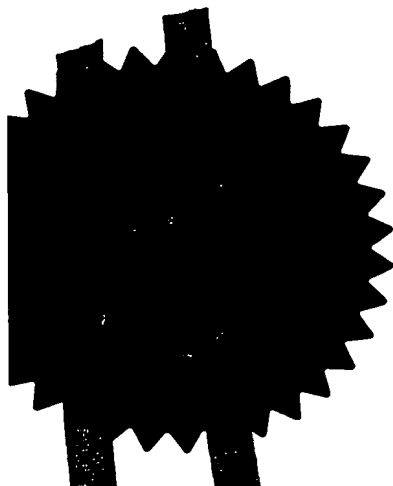
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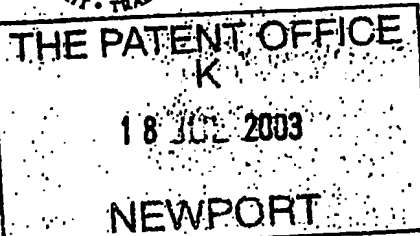
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18 JUL 03 E823627-1 D02481
P01/7700 0.00-0316863.0

Request for grant of a patent

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The Patent Office

Cardiff Road
Newport
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1. Your reference

P34671-NBR/MEA

2. Patent application number

(The Patent Office will fill in this part)

0316863.0

18 JUL 2003

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Hamilton Erskine Limited
17 Moss Road, Ballygowan
Newtownards, Co Down
BT23 6JQ, Northern Ireland

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

9676413001

4. Title of the invention

"Improvements Relating to Glass"

5. Name of your agent (if you have one)

Murgitroyd & Company

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Scotland House
165-169 Scotland Street
Glasgow
G5 8PL

Patents ADP number (if you know it)

1198015

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number
(if you know it)

Date of filing
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

Yes

- a) any applicant named in part 3 is not an inventor, or
 - b) there is an inventor who is not named as an applicant, or
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Continuation sheets of this form

Description

15

Claim(s)

Abstract

Drawing(s)

6 + 6 92

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature *Murgitroyd & Company*

Date
17 July 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

Mark Earnshaw

0141 307 8400

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1 Improvements Relating to Glass

2

3 The present invention relates to improved ballistic
4 and blast- and hurricane-resistant optically
5 transparent composite materials involving glass.

6

7 There have been many suggestions for "bullet-proof"
8 and "blast-proof" transparent windows and the like,
9 either for civilian purposes such as for use in
10 aircraft, or for military purposes, especially
11 protection against enemy and terrorist attack.

12 However, with the developing threat from
13 international terrorism and events such as those of
14 September 11 2001, many governments and major
15 organisations are re-appraising their security
16 requirements. High velocity weapons and better
17 explosives are increasingly available to terrorists
18 and the like. Whilst traditional 'bullet-proof'
19 glass will still be required, there is now an
20 increasing need for certain key installations,
21 persons and equipment, especially in and around
22 military and high governmental locations, to be

1 protected against a higher level of threat than
2 previously considered necessary.

3
4 Where pure optical transmission for a window is not
5 a necessity, there are many available materials
6 having high strength and impact resistance.
7 However, where optical transparency of 'normal'
8 windows and glazing is desired, e.g. for military
9 base houses and offices, current forms of glazing
10 are only adequate for protection against low
11 velocity bullets (e.g. from small arms), and low
12 levels of blast. Most current forms of 'bullet
13 proof' glass use several layers of glass bonded by
14 adhesive polymer film. The energy of the projectile
15 is dissipated over increasingly large areas of
16 blast. To some extent the projectile can be
17 deformed or fragmented and can be deviated from the
18 original line of attack. The energy is directed
19 towards a direction different to the previous path,
20 resulting in further dissipation of energy, e.g. as
21 shown in figure 1.

22
23 Typical design solutions involve either glass/glass
24 combinations or glass/polycarbonate (PC)
25 combination. The latter offer an advantage in that
26 they are lighter than the former, but they often
27 have delamination problems. The effect of bonding
28 of PC to glass is also difficult as PC has a
29 substantially higher rate of thermal expansion than
30 glass. This causes high stress levels in the
31 bonding interlayer during temperature changes which
32 often leads to delamination.

1 The PC designs are often 'complex', particular as
 2 the level of protection required increases. The
 3 number of layers can cause problems with optical
 4 interference and secondary image formation because
 5 of the number of glass/PC interfaces. There may
 6 also be weight or thickness limitations preventing
 7 their use in particular applications. This is shown
 8 in the following tables.

Weapon type & Calibre	Class	Design	Thickness (mm)	Weight (kg/m ²)	Transmittance (%)
Hand Gun 9mm Luger	BR2/C1	6 ² PC5 ² 3-12-ESG6	35	47	77
Rifle 0.223 (5.56*45)hc	BR5/C3	8 ² 6 ² PC6 ² 6 ² PC6 8 ² PC8 ² 6-12- 6 ² PC8 ² 3-20-ESG6	39 82	71 95	64 ?
Rifle 0.308 (7.62*51)	BR6/C4	8 ² 8 ² 6 ² PC6 ² 6 ² PC6 8 ² PC8 ² 3-12- 10 ² PC8 ² 3-20-ESG6	49 85	93 102	? ?
Rifle 0.308 (7.62*51)hc	BR7/C5	6 ² 8 ² 8 ² PC8-20- 6 ² 8 ² 8 ² PC8	91	143	58

29 US5665450 discusses the introduction of glass fibres
 30 and glass ribbons into transparent composites, but,
 31 as it states, the introduction of glass fibres into

1 an optically transparent polymer destroys the
2 transparency of the polymer.

3
4 US5665450 considers that the introduction of glass
5 ribbons provide a higher degree of optical clarity
6 and lower level of distortion than glass fibres.
7 However the photographs in US5665450 indicating the
8 degree of optical clarity of fibre and ribbon-
9 reinforced materials still show distortion even
10 based on photographic reproduction of relatively
11 indistinctive photographs. Figure 7 shows
12 percentage like transmission as a function of
13 temperature and wavelength. However, it can be seen
14 that the percentage transmission barely gets above
15 80% at the lowest temperature and highest wavelength
16 measured. The lowest temperature measured is at
17 30°C, which is also not a temperature generally
18 encountered in many countries on a regular basis. It
19 is interesting that the percentage transmission in
20 US5665450 was not measured at more temperate or
21 freezing temperatures. Moreover, 80% optical
22 transmission is very poor in comparison with the
23 expectancy of 'normal' glass, which should be at
24 least 90% at all temperatures. It is appreciated
25 that the human eye can easily recognise or perceive
26 a less than 100% optical transmission of light
27 through a 'transparent' material.

28
29 In essence, there is a requirement for an optically
30 transparent composite material having about or at
31 least 90% optical transmission over a range of
32 temperatures, including below 0°C, and also able to

1 withstand high velocity ballistic projection whilst
2 having a relatively low manufacturing cost.

3
4 According to one aspect of the present invention,
5 there is provided an optically transparent composite
6 material comprising at least one glass/resin/glass
7 lamination, wherein the resin is a PRR material
8 having optical fibre-reinforcement therein.

9
10 The term "PRR" refers to 'polycarbonate replacement
11 resins', a range of materials provided by Chemetall
12 GmbH of Frankfurt, Germany, and generally defined in
13 their International Patent Application No WO
14 01/38087A1. The PRR materials are a range of
15 transparent cast resins that can consist of reactive
16 acrylate and methacrylate monomers, acrylate and
17 methacrylate oligomers, bonding agents and
18 initiators. The content of WO 01/38087A1 defining
19 these materials is incorporated herein by way of
20 reference.

21
22 The term "PRR" also extends to similarly provided
23 polyurethane resins, often termed "PUR".

24
25 A range of commonly available PRR materials are sold
26 under the trade name Naftlolan®. The Naftlolan
27 materials are provided in a range of different
28 formulations to provide slightly different
29 properties. A list of product data of certain
30 polyurethane Naftlolan materials are listed in
31 Tables 2 and 3 hereinafter, by way of example only.

1 PRR materials have been found to have several
2 advantages over previously used polymer glass
3 lamination layers. Firstly, the refractive index of
4 PRR material overlaps very closely with many types
5 of glass. Secondly, PRR materials have been found
6 to expand and contract at very close rates with that
7 of glass, thus leading to minimal if ever cracking
8 or delamination (due to internal stress) during any
9 thermal expansion and contraction of the composite
10 material. Thirdly, PRR materials are relatively
11 very easy to use and set in transparent composite
12 materials, especially compared with processes of
13 curing previously used types of polymers and resins.
14 They are also useable in designs incorporating
15 complex curves.

16
17 Because PRR materials have a co-efficient of
18 expansion and contraction very close to glass, these
19 materials are usable to provide optically
20 transparent composite materials with glass over a
21 much greater range of temperatures than, e.g. that
22 shown in US5665450. In particular, the present
23 invention is designed to provide a ballistic-
24 resistant optically transparent composite material
25 which is usable at temperatures even as low as -15°C
26 to -40°C , generally -20°C , e.g. the temperature of
27 windows in military installations in certain
28 countries such as Canada, as well as temperatures
29 going up to 30°C to 40°C , such as the temperature of
30 windows in more tropical countries. To that extent,
31 the difference in co-efficiency of glass, such as a

1 normal silica-based glass, and PRR materials,
2 deviates little over a wide temperature range.

3
4 Table 4 hereinafter lists the refractive indices of
5 a number of resins, including a number of the
6 Naftolan range, indicating their close refractive
7 index to that of glass in general.

8
9 In general, the refractive index of the PRR
10 materials are sufficiently close to readily
11 available types of glass, such as a silica-based
12 glass, that the optical transparency of the
13 composite material of the present invention is as
14 good as that from any current glass/glass or
15 glass/PC laminations.

16
17 The fibre reinforcement in the PRR layer of the
18 composite material of the present invention can be
19 provided by any know type of "fibre material", being
20 for instance in the form of filaments, or in the
21 form of particles such as beads, or even powders, as
22 long as such fibre material wholly or very
23 substantially has the same refractive index as glass
24 across all or most the wavelengths of optical light.
25 Such glass fibres are well known in the art, one
26 such available product being sold under the trade
27 name Tyglas by Fothergill Engineered Fabrics.

28
29 The fibre reinforcement provide the PRR intermediate
30 layer with improved strength because of their well
31 known ability to laterally transmit impact energy.
32 Meanwhile, PRR materials also have improved utility

1 as a resin to band the fibre material fillers
2 because of their similar co-efficient of thermal
3 expansion and adhesive strength to glass.

4
5 In the present invention, the thickness of the glass
6 and PRR layers, and the density of fibre
7 reinforcement in the PRR layer, can vary according
8 to the qualities of the final composite material
9 desired. Cost and physical properties are factors
10 in considering the thickness of the layers. One
11 known ratio of thickness is glass/PRR/glass of
12 6/20/4mm; this is provided by way of example only.

13
14 Indeed, a major facet of PRR material is that its
15 strength is independent of its thickness. Many
16 types of resins and adhesives only have strength for
17 a minimal thickness, as their use is to bond
18 together the layers (e.g. of glass) on each side,
19 rather than provide any inherent strength of their
20 own right. PRR has been found not only to provide
21 good bonding to glass, but also have internal
22 strength in its own right. The thickness of the PRR
23 layer is therefore independent of the thickness of
24 the glass layers either side.

25
26 The nature of "high velocity ballistic protection"
27 can be defined in general terms as the difference
28 between a hand gun and a rifle, e.g. above a NATO
29 5.56 or 7.62mm ball.

30
31 According to a second aspect of the present
32 invention, there is provided a process for making an

1 optically transparent composite material as herein
2 before defined, comprising the steps admixing the
3 PRR material with the optical fibre-reinforcement,
4 and allowing the combination to cure and set between
5 the two layers of glass.

6

7 Further information on the curing of PRR resins may
8 be found in WO 01/38087A1.

9

10 Meanwhile, increasing power and sophistication of
11 explosive-technology, means that 'blast-proof'
12 optically transparent material is also desired
13 having increasing strength. In this regard, it is
14 now generally desired to provide blast-resistant
15 optically transparent material having the ability to
16 withstand a blast of 500kg TNT or equivalent at 40m.

17

18 US patent No 3953630 discloses a laminated
19 transparent assembly suitable for use as a
20 windscreen for a high speed vehicle wherein high
21 strength flexible material is embedded in a plastic
22 material, laid between two layers of glass. The
23 flexible material extends beyond the transparent
24 assembly, so as to be directly conjoined with the
25 structure of the vehicle. Thus, as any blast causes
26 deformation of the transparent assembly (as part of
27 the impact absorption), the high strength flexible
28 material provides a direct bond between the vehicle
29 structure bolts and the transparent assembly,
30 hopefully thereby resisting complete separation of
31 the two and travel of the transparent assembly into
32 the vehicle.

1
2 However, US3953630 only discloses the use of
3 polyvinylbutyral (PVB) as the plastic layered to
4 provide the bonding between the glass sheets and the
5 flexible material. In addition, manufacture of the
6 transparent assembly in US3953630 requires an
7 altering of the conventional laminating technique,
8 in order to provide good bonding between a number of
9 PVB sheets, and the glass. This requires pre-
10 heating treatment, insertion of the full assembly
11 including glass sheets in a closed bag to evacuate
12 all air, followed by heating in a autoclave with
13 high pressure. This method of manufacture has not
14 lent itself to cost-efficient production for a
15 number of transparent assemblies, other than for the
16 very special uses such as our aircraft windscreens
17 as mentioned.

18
19 Moreover, PVB in particular is a material only
20 designed to provide good bonding between glass
21 layers. It is typically only 1-2mm thick. Further
22 thickness of layer is not desired, as PVB has little
23 internal strength in its own right.

24
25 In a third aspect of the present invention, there is
26 provided a laminated optically transparent assembly
27 comprising at least one glass/resin/glass
28 lamination, and having one or more high tensile
29 strength flexible material reinforcement pieces
30 extending laterally from the resin layer to provide
31 increased attachment of the assembly to a surround,
32 wherein the resin is a PRR material.

1
2 PRR materials are those as defined herein above. As
3 well as the greater similarity of refractive index
4 and co-efficient of thermal expansion of PRR
5 material to glass, the PRR-flexible material and
6 PRR-glass bonding has been found to be superior to
7 that of prior materials such as PVB.
8

9 Meanwhile, the assembly of the present invention
10 still provides the degree of flexibility desired for
11 a blast-resistant window, with the reinforced
12 attachment of the window to the surround, such as
13 the window rebate of frame.
14

15 The high tensile strength flexible material may be
16 similar to that disclosed in US3953630, i.e. woven
17 fabric or woven glass fibre material or polyester
18 fibre material. One such product is Kevlar®.
19

20 Preferably, the flexible material extends wholly or
21 substantially around opposites sides of the complete
22 transparent assembly, to provide flexibility of
23 attachment to the surround.
24

25 As for the ballistic-resistant material described
26 hereinabove, the thickness of the glass and resin
27 layers of the blast-resistant assembly can follow
28 those well known in the art. One suitable dimension
29 for the glass/resin/glass is 4mm glass, 4mm PRR and
30 3mm glass.
31

1 The thickness of the PRR layer can indeed be up to
2 40-50mm thick, as PRR has inherent strength
3 independent of thickness as mentioned above. To
4 that extent, the PRR material can be as thick and
5 therefore as strong as desired, as all the strength
6 from a blast is taken by the resin (whilst any glass
7 shatters).

8
9 The ability to provide a PRR layer of any thickness
10 provides a further benefit.

11
12 Thus, according to a forth aspect of the present
13 invention, there is provided a blast-resistant
14 composite material comprising at least one layer of
15 PRR material having at least one reinforcement piece
16 extending wholly or substantially across the PRR
17 layer.

18
19 Preferably, the reinforcement piece is a series of
20 strips of bars or other reinforcement means, more
21 preferably forming a grid or grid-like structure
22 wholly or substantially across the composite
23 material.

24
25 The PRR material is that as defined hereinabove.
26 The reinforcement piece can be one or more of woven
27 rovin, webbing, webbing material or even metal
28 material. The use of a metallic grid provides the
29 same effect as a "muntin" system which uses metallic
30 reinforcement grid alongside a glazing panel, but
31 not actually therein. The present invention
32 therefore achieves the same effect and strength as a

1 muntin system, but as a one piece assembly, thereby
2 significantly reducing assembly and installation.

3
4 The blast-resistance is achieved because the PRR
5 layer can be any thickness desired, e.g. up to 40-
6 50mm, which is able to accommodate reinforcement
7 pieces, whereas previous resins were not able to
8 achieve such thickness, and thereby accommodate
9 reinforcement therein.

10
11 The benefit of achieving reinforcement within the
12 PRR material is that each 'section' created by the
13 reinforcement piece or pieces, e.g. each small
14 section within the grid, can be regarded as having
15 its own frame, as thus regarded as a separate
16 section in terms of analysis against blast. As is
17 well known in the art, the blast-resistance of a
18 small section is greater than that of a large
19 section. By dividing the composite panel into a
20 number of small sections, significant blast-
21 resistance is achieved.

22
23 It is noted that the optical transparency of blast-
24 resistant panels using the muntin system is not as
25 important as that described for other aspects of the
26 present invention, so that the comparative
27 refractive index is not as important as that as
28 described above in relation to other aspects of the
29 present invention.

30
31 It will be recognised by those skilled in the art
32 the composite materials and assemblies could also be

1 used to provide hurricane or the like resistance,
2 and thus the present invention is extended thereto.
3 Embodiments of the present invention will now be
4 described by way of example only and with reference
5 to the accompanying drawings in which:
6

7 Figure 1 is schematic cross-sectional view of the
8 impact of a projectile against a current multi-glass
9 laminated window pane;
10

11 Figure 2 is a cross-sectional view of a optically
12 transparent composite material according to one
13 embodiment of the present invention;
14

15 Figure 3 is a laminated optically transparent
16 assembly according to a second embodiment of the
17 present invention.
18

19 As previously mentioned, figure 1 shows how the
20 energy of a projectile is dissipated over
21 increasingly large areas of glass of a known glass
22 PC lamination pane, leading to a large area of glass
23 shattered from the left hand side.
24

25 Figure 2 shows a optically transparent composite
26 material 2 comprising a glass/resin/glass
27 lamination. Within the PRR resin layer 4 are a
28 series of traditional fibre glass woven rovings 6.
29

30 To produce the material, the rovings 6 were secured
31 between two panes of glass 8, and the PRR resin 4
32 was injected into the cavity. The resin 4 flows up

1 the inside of the glass 8 and disperses through the
2 woven roving 6, wetting the fibres and forming an
3 excellent bond.
4

5 Figure 3 shows a blast-resistant assembly 10 mounted
6 to a wall 12. Between the two panes of glass 14, a
7 2 inch wide unidirectional glass fibre woven roving
8 16 was bonded into the same PRR resin 18 as
9 mentioned above. The complete assembly 10 was
10 located in the rebate of a window frame 20, and the
11 roving reinforcement material 16 fixed to the frame
12 20 by adhesive, and also by means of a lateral bolt
13 22.
14

15 The assembly 10 was tested in a Hannsfield 20k-w
16 tensometer. Loads in excess of 8000N were applied
17 before the fibre woven 16 broke. Considerably
18 greater loads could be achieved with the use of
19 thicker fibres or different types of fibres.
20

21 The present invention provides ballistic-resistant
22 and blast-resistant assemblies providing protection
23 against much higher levels of protection from high
24 velocity weapons and explosives than currently known
25 with current forms of glazing. Production of the
26 assemblies is also comparatively simple and cost
27 effective compared to previous types of similar
28 assemblies, which used less suitable polymers and
29 plastic material.

1/8

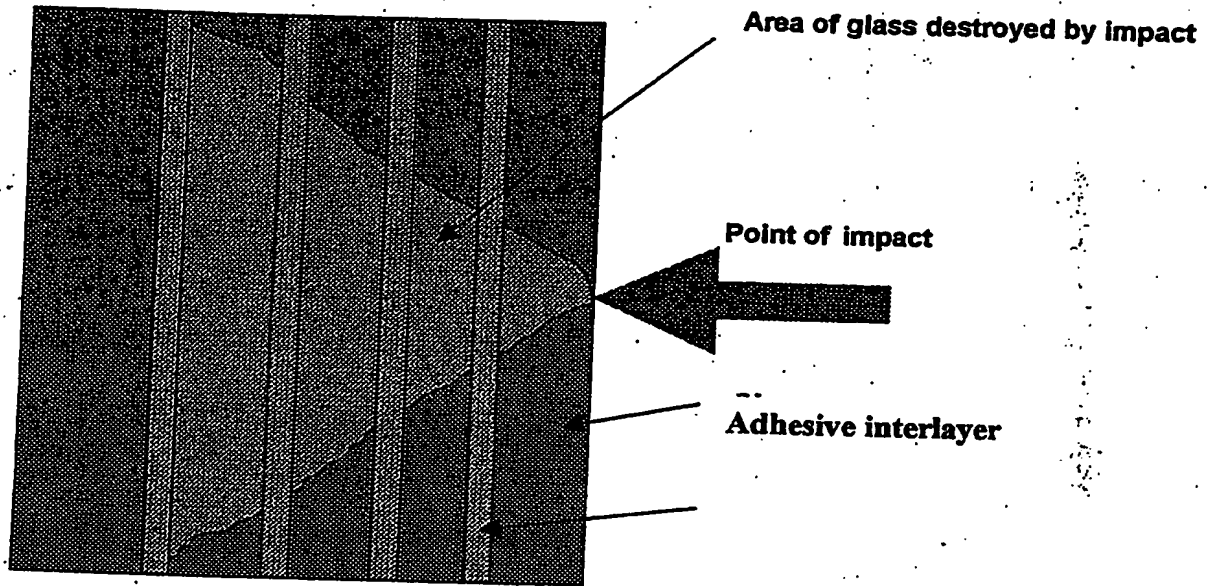


Fig 1

2/6

fig 2

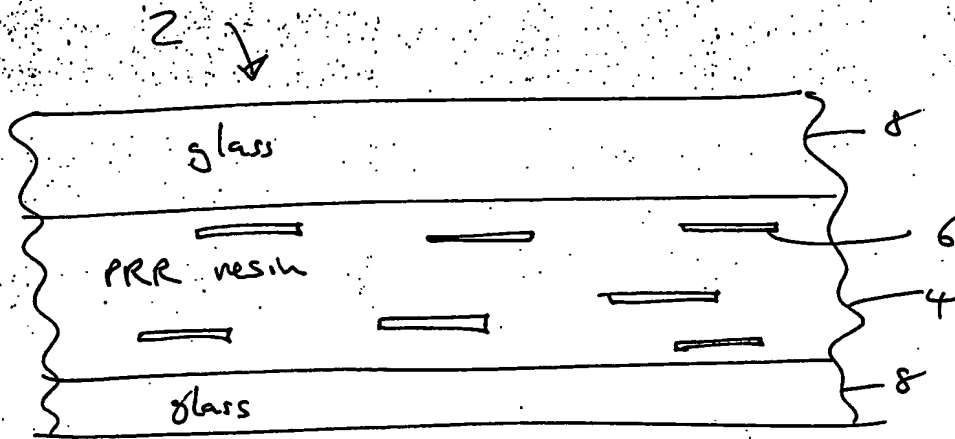
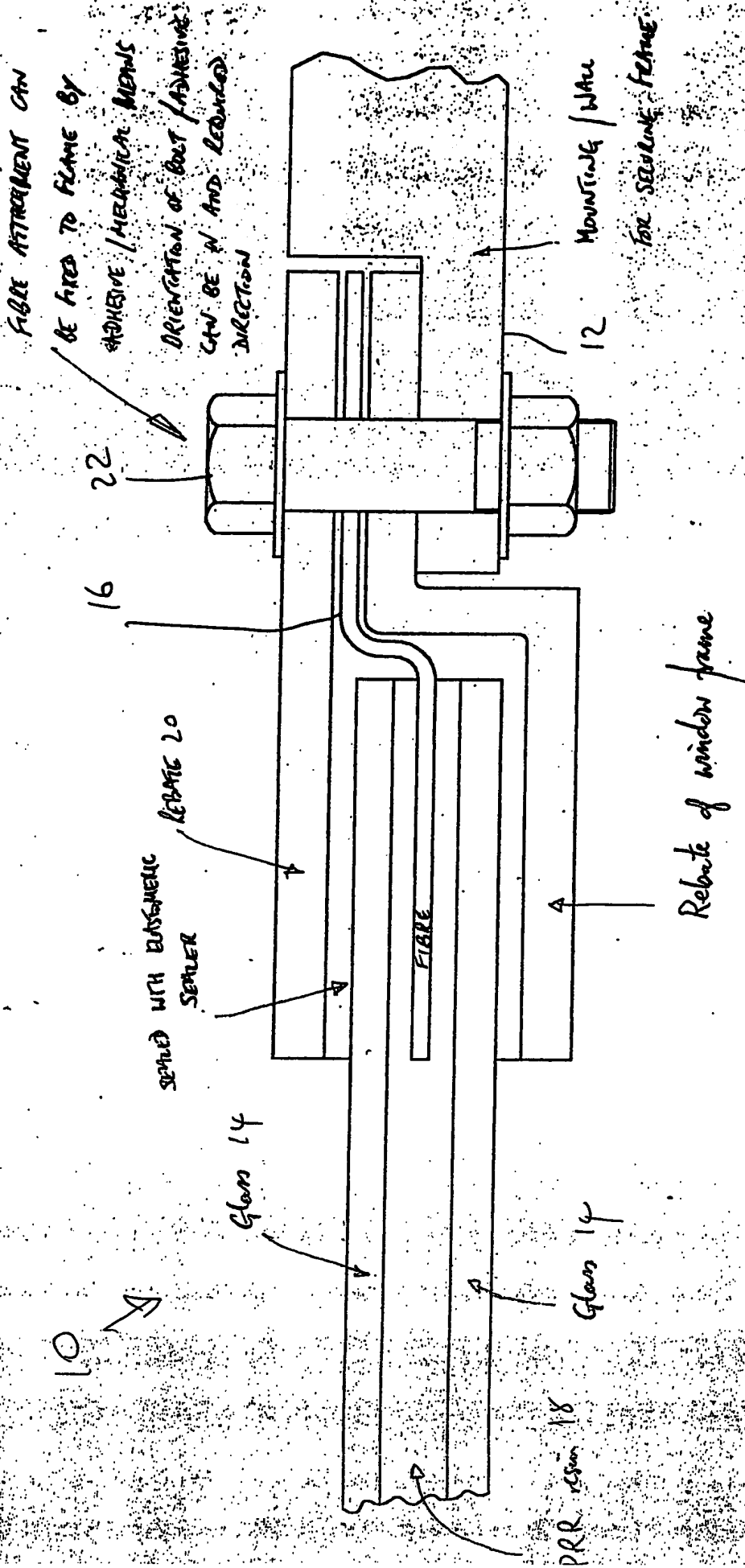


Fig 3



Product Data of Polyurethan Composite Materials

Physical Properties	Naftolan PU-A 700 / PU-B 304	Naftolan PU-A 206 / PU-B 606	Naftolan VP-PA 0911 / VP-PB 2110	Naftolan VP-PA 1011 / VP-PB 2110	Naftolan VP-PA 2601 / VP-PB 2110	Naftolan VP-PA 0511 / VP-PB 2610	Standard
Density							
Max							
Min							
Range possible in one layer							
Strength & Stiffness							
Tensile strength [MPa]	16	16	19	18	5	2.1	DIN 53 504
25% module [MPa]	5	1.2	15	6	1.2	0.7	DIN 53 504
50% module [MPa]	6	1.7	14	7	1.8	1.2	DIN 53 504
100% module [MPa]	8	2.5	15.5	10	3.2	1.9	DIN 53 504
Tensile modulus							
Tensile yield point							
Elongation at break [%]	180	360	150	160	150	120	DIN 53 504
Compressive strength							
Compressive modulus							
Compressive yield point							
Flexural strength							
Flexural modulus (also called modulus of elasticity)							
Flexural yield point							DIN EN ISO 527
In-plane shear strength							
In-plane shear modulus							
Toughness							
Variation with loading rate							
Hardness							
Shore A hardness	90	73	85	80	65	55	DIN 53 505
Adhesion to glass							
Bond shear strength:							
Compression shear strength [MPa] 4/24 mm glass/ glass	18	7.5	20	20	10	2.5	
Thermal							
Thermal coefficient of expansion							
Thermal conductivity							
Specific heat capacity (at 20 °C)							
Resistance							
Resistivity							
Temperature coefficient of resistance							

These values are for guidance only and do not represent a specification.

5/6

Product Data of Polyurethan Composite Materials

Physical Properties		Naftolan PU-A 700 / PU-B 304	Naftolan PU-A 206 / PU-B 606	Naftolan VP-PA 0911 / VP-PB 2110	Naftolan VP-PA 1011 / VP-PB 2110	Naftolan VP-PA 2601 / VP-PB 2110	Naftolan VP-PA 0511 / VP-PB 2610	Standard
Flammability								
Melting point	Because of the molecule structure, the materials do not melt and boil							
Boiling point	Because of the molecule structure, the materials do not melt and boil							
Smoke emission								
Critical Oxygen Index (COI) (minimum oxygen fraction in an oxygen-nitrogen mixture which will support steady state combustion of the plastic. Plastics with COI >0.21 are self extinguishing)								
Chemical Resistance								
Acids								
Alkalis	The materials are not resistant against Alkalis							
Organic solvents	The resistance against organic solvents depends very much on the tested solvents.							
Weatherability/degradation								
Ageing - temp cycling test	Tests according to DIN 1286 with different kind of laminates were passed without failures.							
UV absorption	See the transmission data on the next sheets							
Adsorption of water								
Additional Data								
Viscosity (23°C) [mPa·s]	Component A	450	320	600	515	435	360	
Viscosity (23°C) [mPa·s]	Component B	3250	85	85	85	85	85	
Viscosity (23°C) [mPa·s]	Mixture	2550	200	225	200	245	230	
Specific weight (23°C) [g/cm³]	Component A liquid	1.02	1.01	1.03	1.02	1.02	1.01	
Specific weight (23°C) [g/cm³]	Component B liquid	1.04	1.05	1.05	1.05	1.05	1.05	
Specific weight (23°C) [g/cm³]	Mixture liquid	1.04	1.037	1.04	1.03	1.03	1.02	
Volume Shrinking [%]		2	2	4	4	3	2	
Processing time (23°C) [min]		45	15	40	30	30	30	
Curing time (23°C) [h]		12	48	12	24	24	12	
Storage time before delivery (18°C to 23 °C) [d]		4	6			4		
Shore A hardness after 1 day (cured resin) DIN		65		75	65	50	40	
Shore A hardness after 7 days (cured resin)		90	73	95	90	65	55	
Thermal conductivity (DIN 52612) [W/(m·K)]		0.18						DIN 52612
Transmittance (DIN 67507) (assembly 6/8/4mm) [%]		90						DIN 67 507
Transmittance (DIN 67507) (assembly 6/12/4mm) [%]		88						DIN 67 507
Transmittance (DIN 67507) (assembly 6/20/4mm) [%]		88						DIN 67 507

These values are for guidance only and do not represent a specification.

Table 4

Refractive Index liquid / cured Resins (at 20°C)

Resin	n_{D20} liquid	n_{D20} cured
UV 11	1,4362	-
UV 22	1,4417	1,4813
UV 33	1,4396	-
ICE-Gießharz EP 1309-103	1,4434	-
UV 203	1,4370	1,4713
S 700 M	1,4299	-
S 696 M	1,4272	-
Naftolan VP-PA 0511	1,4542	-
Naftolan VP-PA 1011	1,4568	1,4844 *
Naftolan PU-A 206	1,4540	-
Naftolan VP-PB 2110	1,4169	-
Naftolan PU-B 606	1,4777	-
Naftolan VP-PA 2601	1,4553	-
Naftolan PU-A 700	-	-
Naftolan PU-B 304	1,4739	-

* cured with corresponding B component

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